Space Weather Technical Forecast

Issued on Friday, 07 October 2022 at 01:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Potential CME arrival early day 1 (7th), with a chance of G1 Minor - G2 Moderate storms. Chance of isolated M-flares with a very slight chance for X-flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low, with only C-class background flares in the last 24 hours. There are six numbered regions on the visible disc, and one further small, unnumbered flux emergence area in the northeast. AR3112 Fki/Beta-gamma-delta is a large and complex region, although has remained relatively stable despite the presence of a compact intermediate region with a couple of delta spots visible. Now approaching the centre disc, magnetic maps possibly suggest that this region is comprised of three separate, but close proximity regions. This could elude as to why the region appears to be less active than would be expected for one, large complex group. AR3116 Eai/Beta, to the north of AR3112, is the other main region of interest, with some small spot proliferation and growth in its intermediate region. The remaining regions are all relatively simple and currently inactive. No Earth-directed CMEs have been observed in the last 24 hours, although the solar disc has a number of filaments which would have the potential to produced Earth-directed CMEs if they lift off.

Solar Wind / Geomagnetic Activity: Solar winds observed by DSCOVR at L1 likely showed the continuing peripheral influence of a CME. Speeds have persisted at slightly elevated to elevated levels, between 450-540 km/s. Density was observed close to the average to above average threshold throughout the period. The total IMF strength (Bt), has been weak, with a peak of 7.1nT at 06/0845 UTC. The north-south component Bt, remained weak varying between -7 and +6nT, but more frequently in a negative (southward) direction. The phi angle was predominately positive (away from the Sun). Resultant geomagnetic activity was Quiet to Active (Kp1-4).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, has been at background levels. High energy electron flux (greater than 2 MeV) increased from moderate to generally high levels from 06/1435 UTC, peaking at 2.40e3 pfu at 06/1630 UTC, before erratically returning to moderate levels late in the period. Electron fluence remained below the Active threshold, with a slowly increasing trend since 06/0000UTC. The observed fluence at 07/0000 UTC was 6.25e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low to Moderate, with the activity risk predominately attributed to the large northern sunspot AR3112. There is a very slight chance of this increasing to High.

Solar Wind / Geomagnetic Activity: A CME which left the Sun on the 4th, resulting from a filament eruption in the southern central disc has the potential to arrive at Earth early day 1 (7th), although confidence for this to occur is Low. This may lead to slightly elevated to elevated winds persisting through day 1. Otherwise current fast winds are expected to gradually fade, before the next fast wind enhancement either later day 2 (8th) or day 3 (9th) from CH29, continuing into day 4 (10th). Geomagnetic activity is forecast to be Unsettled to Active at first, but with a chance of

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increasing to G1/Minor to G2/Moderate storm from any CME arrival on day 1. Activity should then ease to Quiet to Unsettled for a time by day 2, but with a chance of Active intervals and a slight chance of G1/Minor Storms again from any fast wind arrival from CH29 later in the period, mainly on day 3.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) is expected to be near background for much of the period, but with a very slight chance of minor proton storms, most likely due to AR3112. Electron flux is likely to increase following from the recent CME sourced suppression, with an increasing chance of reaching High through the period. However, the further CME arrival possible early day 1 gives low confidence for this recovery. This will bring a likely risk of associated 24 hour electron fluence reaching Active from day 2 (8th). The risk may diminish slightly later in the period as the anticipated coronal hole suppresses electron counts again.

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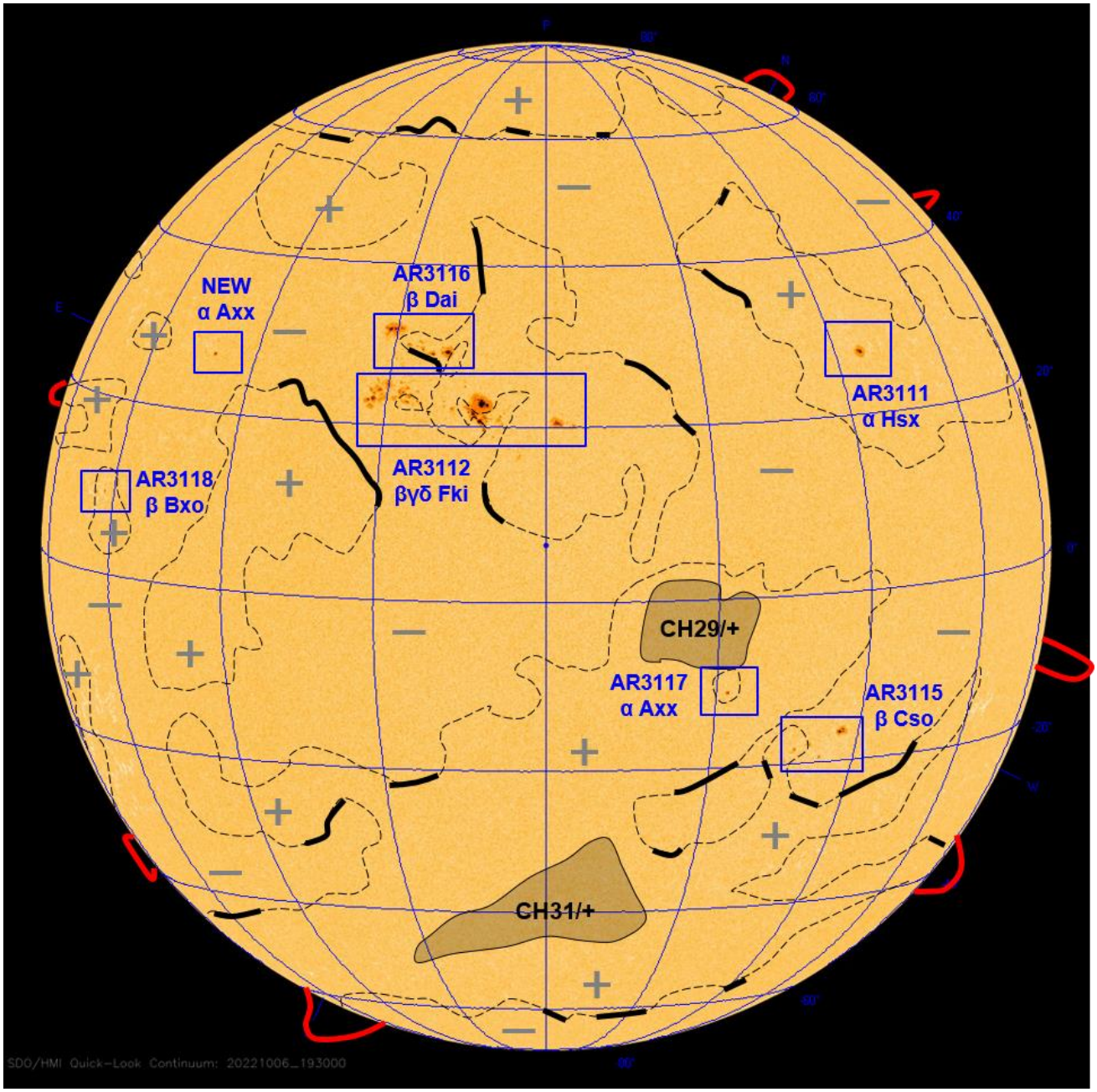
Figure 1. Solar Analysis Valid 06/1930 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A filament eruption around 04/1300 UTC resulted in a CME that was analysed as passing mostly to the south of Earth late on 6th, but with a chance of arriving at Earth around 06/2100 UTC +/- 12 hours. This has lower than usual confidence due to only limited SOHO Lasco coronagraph imagery being available for analysis at the time.

Solar winds at Earth likely remain enhanced by another weak CME arrival, perhaps due to the large SE quadrant filament eruption on the 3rd. This only brought peripheral influences but has maintained slightly elevated to elevated solar winds at around 500km/s. In the absence of any further CME interaction, these would be expected to gradually ease through the period, however the possible arrival early on day 1 (7th) is likely to result in elevated winds persisting, before gradually easing later day 1 or on day 2 (8th).West of central disc CH29 is a new feature on this rotation and a further slight enhancement is likely later day 2 (8th) or during day 3 (9th) as Earth encounters its fast wind. This low confidence however, due to a lack of persistence, and also no notable signal from this feature is present in current Enlil model winds.

Geomagnetic activity is forecast to be Unsettled to Active at first, but with a chance of increasing to G1/Minor to G2/Moderate storm from any CME arrival on day 1. Activity should then ease to Quiet to Unsettled for a time by day 2, but with a chance of Active intervals and a slight chance of G1/Minor Storms again from any fast wind arrival from CH29 later in the period, mainly on day 3.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	40	10	20	10
Strong	G3	No	2	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
04/1734	Partial	Filament	SW	980 km/s	07/0000 (+ 0 to 12 hrs)	Low confidence fit with limited LASCO imagery. Passes mainly to the south.

Figure 2: Most recent Enlil showing potential CME arrival, with ensemble showing wide spread of potential impact times.

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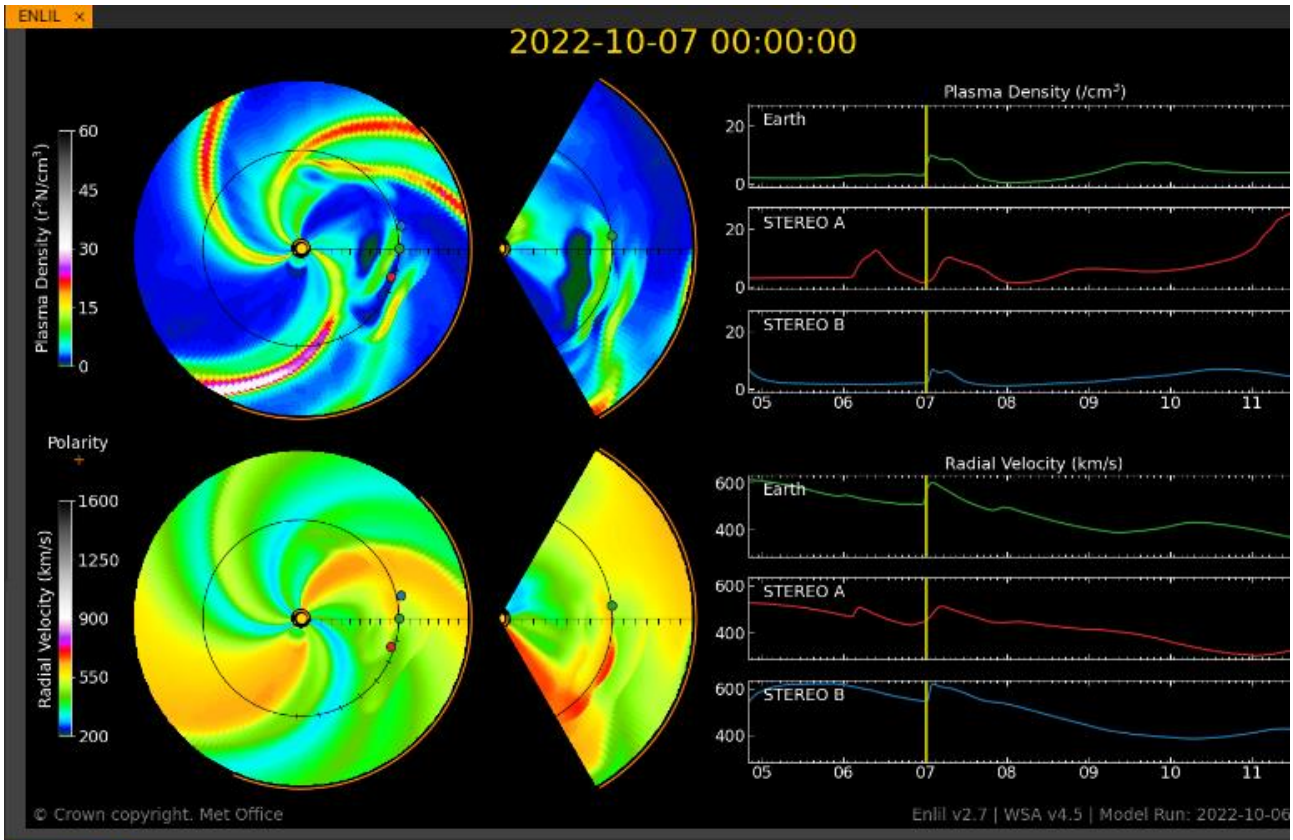

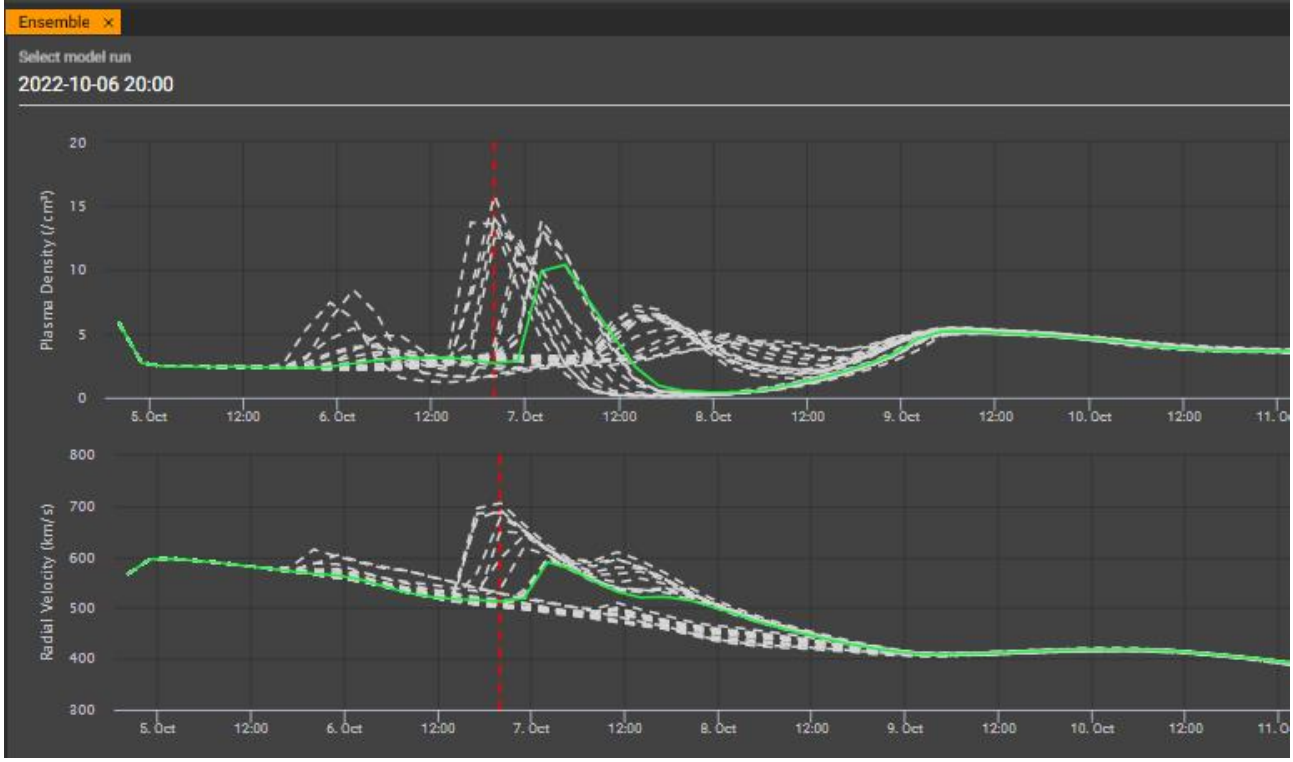

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Radio Blackouts - X-Ray Flares:

Solar activity is at Low levels with only background C-class activity during the last 24 hours. Low to Moderate activity is expected to continue. There are six numbered regions visible on the Earth-facing disc, along with one new but small flux emergence in the northeast quadrant.

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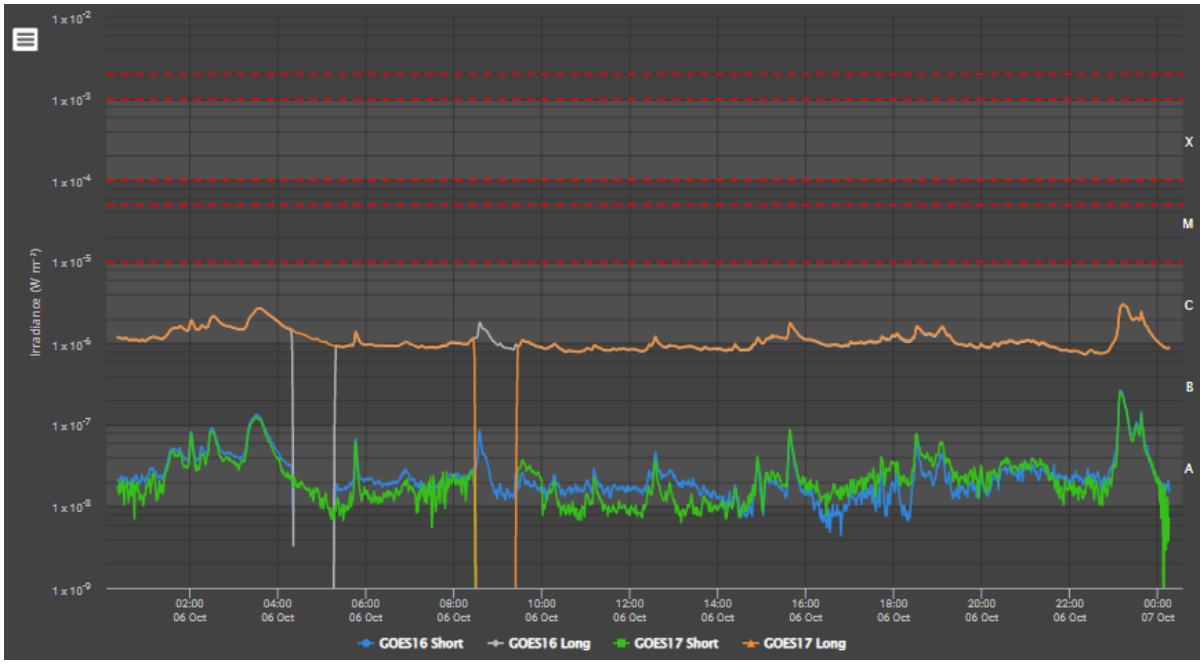
X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	50	40	40	40
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: GOES 16-17 X-ray flux



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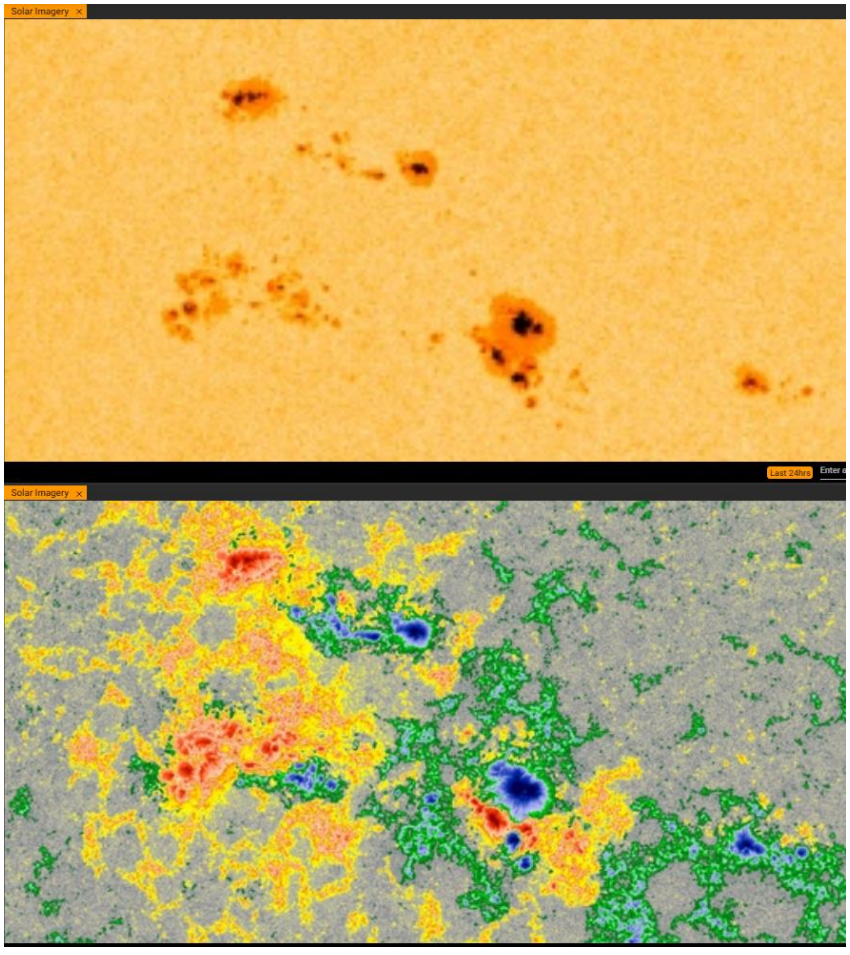
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) as observed by GOES16 is currently at background levels. There is a very slight chance of exceeding the S1 threshold, primarily from AR3112 near centre disc given any sufficiently strong flare event, but also from just over the limb due to any further M or X-flares from ex-AR3110 which rotated off the Earth-side disc in the past day or so.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: SDO intensitygram and Magnetogram of AR3112 and AR3116 at 06/2330 UTC



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High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2 MeV), as measured by GOES-16 has recently been suppressed due to the glancing CME influences observed late on the 5th and early 6th, though electron counts have generally risen today, with a period of high flux levels being observed at diurnal maxima. A further possible CME arrival early day 1 (7th) has the potential to suppress observed values until any effects from this eases later day 1 or on day 2 (8th). As solar winds ease, especially into day 2 and day 3 (9th), there is an increasing chance of high flux levels being observed more persistently, although this is likely to again become suppressed from any fast wind arrival from CH29 late day 3 or day 4 (10th).

The associated 24 hour electron fluence is expected to remain below the Active threshold day 1 (6th). Any potential rise above Active day 1 (7th) will be dependent upon the extent and duration of any CME impact. However, flux is likely to rise sufficiently by day 2 and 3 to give a period of Active Fluence before the arrival of the fast wind of CH29 suppresses observed flux levels again later in the period. REFM is likely giving poor guidance at the moment, due to its inability to account for the recent peripheral CME influence, along with the potential CME arrival early on day 1.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	30	60	60	40
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

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Figure 5: GOES-16 >MeV Electron Flux and Fluence with REFM

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